"Mirror Mirror on the Wall, Who is Real of Them All?" – The Role of Augmented Self, Expertise and Personalisation in the Experience with Augmented Reality Mirror

Ana Javornik*
ana.javornik@ncl.ac.uk
Newcastle University Business School
5 Barrack Road, NE1 4SE Newcastle upon Tyne
United Kingdom

Marta Pizzetti
marta.pizzetti@usi.ch
Institute of Marketing and Communication Management
Università della Svizzera italiana
Via Giuseppe Buffi 13, 6900 Lugano
Switzerland

Abstract:
This research calls for studying the concept of self in the context of increasingly popular augmented reality mirrors. We introduce the notion of "augmented self" and demonstrate in two experimental studies how different types of augmentation with virtual make-up impact the consumer's perception of herself and the products.

*Corresponding author

"Mirror Mirror on the Wall, Who is Real of Them All?" – The Role of Augmented Self, Expertise and Personalisation in the Experience with Augmented Reality Mirror

Ana Javornik, Newcastle University Business School, United Kingdom
Marta Pizzetti, Università della Svizzera italiana, Switzerland

INTRODUCTION

Augmented reality (AR) sets itself apart from other interactive technologies in that it overlays physical environment with virtual annotations in real-time, meaning that they react to the user's movements as if really existing in the physical environment. In the heterogeneous class of AR devices and applications (Scholz and Smith 2016), AR mirrors with front-facing cameras are especially on the rise as they represent the most advanced version of virtual try-on in terms of real-time fit. As if seeing herself in the mirror, the user views her image on the screen, which appears modified with virtual representations of products (Javornik 2016). Such technology represents an elegant solution for trying on more products in comparison to physical testers or products. Due to the immediacy of how the virtual products appear and disappear from one's image, the consumer can explore more choices with minimum effort (Kim and Forsythe 2008). Given that the AR try-on directly modifies one's image in the mirror, it is important to understand how consumers perceive such augmented images, how they relate to the products that constitute such augmentation and, finally, what the resulting behavioural intentions are.

The present research aims to fill this knowledge gap by investigating the effect of AR try-on on the level of self, the product and the behavioural intentions. Two experimental designs compare different forms of AR in order to investigate the effects of such technology on the different levels of the experience (i.e. the self, the product and the intentions), but also to shed light on the most effective way of using AR.

THEORETICAL FRAMEWORK

Digital and virtual technologies were shown to have an effect on the self (Schau and Gilly 2003; Siddiqui and Turley 2006; Sheth and Solomon 2014). Following the idea of "extended self" (Belk 1988; Belk 2013) and "malleable self" (Aaker 1999), Jin (2012, 2161) proposed the concept "virtual self" which refers to "the technology-mediated self simulated in virtual environments". When creating virtual avatars, users in her study felt a stronger self-connection with those avatars that represented their ideal self than with the avatars that represented their actual self (Jin 2012). What happens when the users see such an enhanced version of the self not only on the screen, but superimposed on their own image in a mirror? Does the consumer create a closer connection to the augmented image when she feels that such augmentation represents an enhanced or improved self?

Unlike in virtual reality, in AR augmentation happens in real-time; the virtual annotations are overlaid directly onto the face; and the fusion of the self and the image is much more realistic (Azuma et al. 2001). With virtual try-on mirrors, the virtual elements are embedded seamlessly as part of the mirrored image and thus appear as a realistic part of the self. Given such superimposition, we expect that the *virtual augmentation of the self in the AR mirror* and the *perception of such virtual augmentation* allow for an emergence of an *augmented self* that we define as *a modified perception of the self that is based on an augmented representation*.

However, we expect that the augmented self can appear only under specific conditions. First, following the line of research that examines the relationship part-whole in consumer behavior literature (Labroo, Dahr and Schwarz 2008), it should be easier for consumers to appreciate the virtual products when they appear in the context of a holistic augmented image (where multiple virtual annotations appear in unison) in contrast to seeing a partial augmentation (where only one part of the image is overlaid with virtual augmentation). Both Gestalt theory (Schiffman 2001) and conceptual fluency (Lee and Labroo 2004) underline the importance of the additional cues and context that allow a user to process and relate to a particular part. In the context of AR, a product would be perceived more as a part of the "augmented self" when additional augmentation cues are offered. It would mean that a holistic augmentation, which superimposes elements on the whole image, has a stronger effect on the perception of the self, compared to a tool that superimposes virtual annotations only over a small part of the image. More formally:

H1: Holistic (vs. partial) augmentation of the self significantly impacts the perception of the self.

The second condition for such enhanced self-perception relates to the personalization of the augmentation. The literature on personalization established that creating a product increases the perception of uniqueness, but also allows the consumer to better express her desires compared to standardized, mass-produced products (Franke et al. 2009). We can then expect that, when a consumer can personalize the augmentation, meaning that she can modify the elements superimposed on the mirrored image, she can find a look that better matches the desired image, resulting in a greater perception of augmented self. However, the level of subjective knowledge or expertise is crucial in the process: previous studies have shown that those with higher level of expertise prefer to have more options to customize the look (Randall et al. 2007; Moreau et al. 2011; Javornik et al. 2017). Thus, we might expect that AR would be more impactful in terms of increasing self-perceptions when the users are able to personalise it.

H2: Personalising holistic augmentation (vs. not personalising) leads to a more positive perception of self when the consumers are knowledgeable about the products that constitute the augmentation.

Another important issue is how the real products are perceived in this process. As the virtual enhancement is a visual representation of actual products, we hypothesize that when a positive perception of the enhanced self is established, this perception will relate not only to the mirrored augmented image of the self, but would also transfer to the products, as the augmentation is effectively a result of the virtual products. The augmented self is an outcome of virtual simulation of products and thus the self-perception that results from viewing the (holistic) augmented self would be associated with those products. Peck and Shu (2009) show that mental imagery can generate a sense of ownership over a product even if the product is not available to touch. Moreover, literature on psychological ownership suggests a positive relation between psychological ownership and behavioural intentions (Jussila et al. 2015).

We thus postulate that when an AR mirror displays a simulation of how such products would look on one's face and when such a simulation increases one's self-perception, this would lead to greater psychological ownership of the products, which would further impact the purchase intentions.

H3: Effects of holistic (vs. partial) augmentation on the intentions to purchase the visualized products are mediated by self-perception and then psychological ownership (H3a), especially when the augmentation is personalized (H3b).

METHODOLOGY

We conducted two experimental lab studies with a make-up virtual try-on. The application was created especially for the aim of this research in collaboration with an agency specializing in AR. As make-up is predominantly a female product category, the participants were female only. They were under- and post-graduate students recruited from a British university pool, between 18 and 29 years old and they received a small monetary incentive.

In both experiments, respondents completed a questionnaire, answering questions before and after the task. Their task was to find a lipstick (Study 1) or a full make-up look (Study 2) that they liked best and they thought fitted them the most. After the task, the self-perception, psychological ownership (6 items from Fuchs et al. (2010)) and purchase intention (2 items from Li and Meshkova (2013)) were assessed. Self-esteem was used as a proxy for self-perception, given that self-esteem is conceptualized as one of the main dimensions of the self concept (Sirgy 1982). Self-esteem was measured with 6 items from Heatherton and Polivy (1991) and assessed before (T1) and after (T2) the task in order to verify potential differences between groups prior to the experiment (T1) and its variation after. All the measurement items were on a 7-Likert scale and Cronbach alphas are reported in Table 1.

STUDY 1

Study 1 tested H1 and H3a in a single factor between-subject design (AR: holistic vs. partial) that involved 51 participants, randomly assigned to the conditions.

AR was manipulated by simulating more (vs. less) superimposed objects on the face of the participant. Specifically, in the holistic condition a complete AR make-up look (set in advance with mascara, foundation, eyeshadow, blush and eyeliner) was virtually overlaid on participants' face while choosing the lipstick, which was also virtually overlaid. Participants in the partial condition had their faces overlaid only with virtual lipstick with no other virtual make-up available.

Findings

The participants in the two groups did not have different self-esteem at T1, but a significant difference was found at T2 with participants reporting higher self-esteem for holistic AR. Moreover, in the holistic augmentation the participants experienced greater psychological ownership compared to those who tried only the lipstick, although purchase intentions did not differ. Means, standard deviations and ANOVA indexes are reported in Table 1.

In order to maintain the same condition, the participants in the holistic augmentation group needed to be exposed to the same look. We tried to design the look to be neutral (i.e. avoiding excessive features). Nevertheless, the suitability of a full make-up can still vary depending on the facial features and personal taste (e.g. the foundation could appear more or less fitting depending on the skin tone). We accounted for the different attitudes towards the make-up look superimposed by asking users to rate the make-up look (without the lipstick) on a Likert scale from 1(do not like at all) to 7(like very much). As 6% of the participants did not like the look, we excluded them from the analyses, as the dislike could have potentially affect their experience.

Within this subset of participants (N=48), the analyses revealed significantly higher self-esteem (T2), psychological ownership and purchase intention for the holistic condition. Moreover, a bootstrapping mediation analysis with 5,000 resamples (Model 6; Hayes, 2012) showed that self-esteem at T2 and psychological ownership mediated the relationship between AR and intention to purchase.

The results provided preliminary evidence for the effect of AR on the perception of the self. Specifically, they suggest that a holistic augmentation provides a more powerful experience in terms of positive self-perception in comparison to a partial augmentation. The higher self-esteem is associated with psychological ownership, which mediates the effects on the intention to purchase. The mediation showed significant indirect effects, indicating a fully mediated relationship (Hayes 2009; Zhao et al. 2010).

We now further explored if the augmented self differed across various types of holistic augmentation, also because the suitability of the full make-up appeared crucial for the experience.

STUDY 2

A 2 (holistic AR: personalised vs. not-personalised) x 2 (make-up expertise: high vs. low) between-subjects design was conducted involving 97 participants. In all the conditions, AR was holistic, meaning that a complete look was superimposed (i.e. the look included mascara, foundation, eyeshadow, blush and eyeliner), but the holistic AR experience differed between conditions to allow greater (vs. lower) look personalisation. Specifically, in the personalised condition, the participants created their own looks by deciding within a wide range of available virtual lipstick, foundation, eyeshadow, eyeliner, mascara and blush. In the non-personalised condition, the participants could select among 13 pre-designed looks that were set in advances by the researchers. They included make-up from the same categories that were available in the personalised condition. These pre-defined looks were composed in a manner that they offered a variety of colours, strength of effect (subtle vs. strong look) and a combination of products. Make-up artists and brands like Charlotte Tilbury and Rimmel offer virtual try-on of signature looks, thus we deemed the approach reflected a realistic practice. We also measured participants' subjective knowledge in order to take into account how much they perceived themselves to be experts about this product category. It was assessed with 9 items on a 7-point Likert scale (adapted from Flynn and Goldsmith (1999)). The participants were divided into the groups of high and low subjective knowledge by median split (median = 4.44).

Findings

Self-esteem at T1 did not differ across the four conditions, while a significant interaction effect was found at T2: expert participants in the personalised condition reported the highest scores of self-esteem ($F= 5.696$, $p< .05$). However, we did not find a significant effect of the two factors on psychological ownership and purchase intentions.

We now examined only the experts' responses (N=50). Although we did not find a variation in terms of psychological ownership and purchase intention across the two holistic AR conditions, we found that the relationship between AR and purchase intention is fully mediated by self-esteem (T2) and psychological ownership as in Study 1.

The results of Study 2 thus offer an additional support to the findings of Study 1, confirming the mediating role of self-esteem and psychological ownership between AR and intention to purchase - when the AR user possessed a high expertise (supporting H3b). Moreover, the self-esteem is higher for expert users when they personalised the make-up as opposed to those expert users that didn't (supporting H2).

Table 1. Means and *standard deviations*, ANOVA and mediation indexes for Study 1 and 2

Study 1							
	Total sample (N=51)		***Subsample: those who like the look (N =48)***		***Scale reliability***	***Mediation (N= 48)***		
	Partial	*Holistic*	*Partial*	*Holistic*		*Path*	*b*	*sig*
Self-esteem T1	4.72*(1.08)*	5.15*(.97)*	4.72*(1.08)*	5.17*(.91)*	α =.902	AR → self-esteem T2	.78	p <.05
	F = 2.204 p >.05		F = 2.424 p > .05			Self-esteem T2 → Psychological Ownership	.35	p <.05
Self-esteem T2	4.75*(1.34)*	5.43*(1.02)*	4.75*(1.34)*	5.53*(.91)*	α =.949	Psychological ownership → purchase intention	3.19	p <.01
	F = 4.243 p <.05		F = 7.332 p <.05			AR → Purchase intention	.34	p >.05
Psychological ownership	4.51 *(1.24)*	5.17*(.99)*	4.51 *(1.24)*	5.17*(1.01)*	α =.898	AR → Self-esteem T2 → Psy. Ownership → Purchase intention	.09	p <.05
	F = 4.502 p <.05		F = 4.059 p <.05					
Purchase intention	5.50*(1.01)*	5.75*(1.28)*	5.50*(1.01)*	6.09*(.67)*	α =.764	.02 <95%CI <.30		
	F = .595 p >.05		F = 5.531 p <.05					
Study 2								
	Not-personalized (N=44)		**Personalized (N=53)**		**Scale reliability**	**Mediation (experts only, N=50)**		
	Expert	*Non-expert*	*Expert*	*Non-expert*		*Path*	*b*	*sig*
Self-esteem T1 (total sample N=97)	4.53*(1.47)*	4.67*(1.30)*	5.31*(.86)*	4.73(.88)	α =.908	AR → self-esteem T2	.83	p <.05
	Main effect AR F=3.316 p >.05; Main effect expertise F=.870 p >.05; Interaction F = 2.339 p >.05					Self-esteem T2 → Psychological Ownership	.35	p <.05
Self-esteem T2 (total sample N=97)	4.84*(1.54)*	4.93*(1.45)*	5.67*(.86)*	4.71 *(.93)*	α =.926	Psychological ownership → purchase intention	.57	p <.001
	Main effect AR F=1.555 p >.05; Main effect expertise F= 3.063 p >.05; Interaction F = 4.525 p <.05					AR → Purchase intention	-.14	p >.05
Psychological ownership (total sample)	4.75*(1.57)*	4.73*(1.11)*	5.49*(1.27)*	4.92*(1.26)*	α =.898	AR → Self-esteem T2 → Psy. Ownership → Purchase intention	.16	p <.05
	Main effect AR F=1.061 p >.05; Main effect expertise F=3.038 p >.05; Interaction F = 1.254 p >.05							

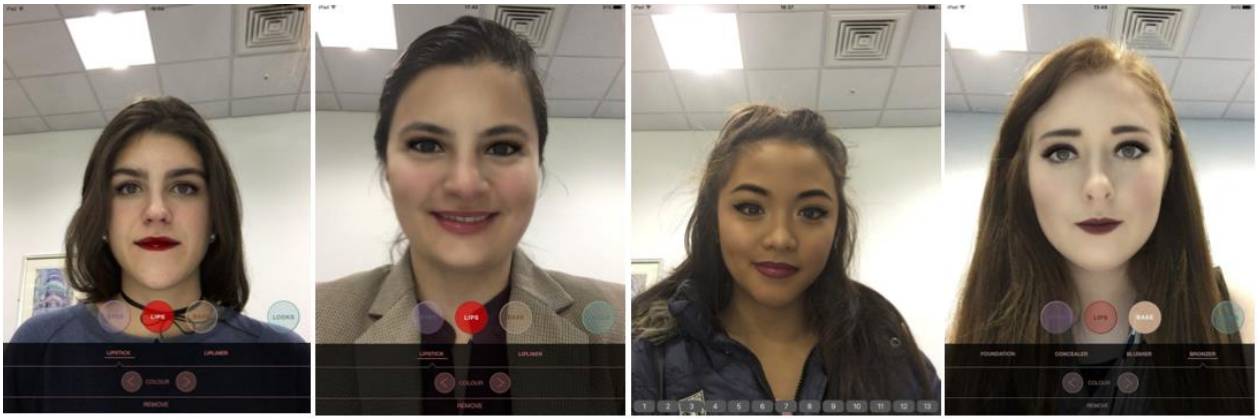

Figure 1: Participants from the two studies: 1) trying only the lipstick in partial augmentation condition in Study 1 (extreme left), 2) trying the lipstick while generic holistic make-up is also visualized on the face in holistic augmentation condition in Study 1 (middle left); 3) choosing between 13 predesigned looks in Study 2 (middle right); 4) customizing a complete look in Study 2 (extreme right)

GENERAL DISCUSSION

The two experiments provide evidence that when the AR tool superimposes a holistic, instead of partial, augmentation and consequently creates an impression of a more complete simulation, this strongly affects how consumers perceive themselves (their self-esteem increases) and the product (they experience a stronger psychological ownership of a product). Such a change in the self perception offers a preliminary support for the idea that using AR allows for the emergence of the augmented self. Consequently, a relationship is established also with the products that were visualized as part of such augmented self. Positive appreciation of such augmented representation is, importantly, indispensable to this phenomenon. In Study 1 the effects were significant only if consumers liked the holistic look.

Furthermore, Study 2 showed that a holistic augmentation was particularly effective for the emergence of the augmented self when it allowed the consumer to personalise the experience. Such personalisation increased self-esteem compared to the holistic AR where the looks were pre-defined. However, the role of expertise in personalisation of AR looks appeared crucial for understanding the effects of augmented self on psychological ownership and purchase intentions. Study 2 reveals that the augmented self emerges only when customers are already knowledgeable about make-up, but is hindered by low expertise. Customizing a complete AR make-up look might appear too challenging for someone who knows little about this product category. Non-expert customers do not experience the emergence of the augmented self and consequently personalized AR does not increase their intentions to purchase.

CONCLUSION

This study contributes to the understanding of the "self" in virtual try-on with AR, highlighting the relevance of providing a holistic experience for augmented self. This offers useful insights for marketers into consumer experience with AR mirrors. However, extensive further research is required. Would a recommendation system integrated as part of the mirror (or advice by shop assistant) overcome the barrier that a lack of expertise represents? Also, going beyond this product category, what are further characteristics of augmented self in other contexts where augmentation is related to the whole body, a personality trait or a specific skill? Consumer research should follow up the technological developments with a clearer understanding of "augmented self".

Acknowledgements:
This research received UCL Knowledge Exchange and Enterprise Funding from EPSRC Impact Acceleration Account (EP/ K503745/1) and funding from KITE centre at Newcastle University Business School. The authors would like to thank Prof Anthony Steed and Prof Yvonne Rogers from UCL for their support of the project and Dr Ana Moutinho, Maria Jose Garcia Sopo, Dr Russell Freeman and Jonathan Chippindale from company Holition Ltd for their invaluable help with the design of AR apps.

REFERENCES

Aaker, Jennifer L. (1999), "The Malleable Self: The Role of Self-Expression in Persuasion," *Journal of Marketing Research (JMR)*, 36(1), 45–57.

Azuma, Ronald, Reinhold Behringer, Simon Julier, and Blair Macintyre (2001), "Recent Advances in Augmented Reality," *IEEE Computer Graphics and Applications*, 21(6), 34–47.

Banister, En and Mk Hogg (2004), "Negative Symbolic Consumption and Consumers' Drive for Self-Esteem: The Case of the Fashion Industry.," *European Journal of Marketing*, 38(7), 850–68.

Belk, R W (2013), "Extended Self in a Digital World," *Journal of Consumer Research*, 40(3), 477–500.

Belk, Russell W. (1988), "Posessions and the Extended Slef," *Journal of Consumer Research*, 15(2), 139–68.

Franke, Nikolaus, Peter Keinz, and Christoph J Steger (2009), "Testing the Value of Customization: When Do Customers Really Prefer Products Tailored to Their Preferences?," *Journal of Marketing*, 73(5), 103–21,

Fuchs, Christoph, Emanuela Prandelli, and Martin Schreier (2010), "The Psychological Effects of Empowerment Strategies on Consumers' Product Demand," *Journal of Marketing*, 74(1), 65–79.

Gao, Leilei, S Christian Wheeler, and Baba Shiv (2009), "The 'Shaken Self': Product Choices as a Means of Restoring Self-View Confidence," *Journal of Consumer Research*, 36(1), 29–38, http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=41224314&site=ehost-live.

Hayes, Andrew F (2012), "PROCESS: A Versatile Computational Tool for Observed Variable Mediation, Moderation, and Conditional Process Modeling," in *An Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*, New York: Guilford Press, 1–39.

Hayes, Andrew F. (2009), "Beyond Baron and Kenny: Statistical Mediation Analysis in the New Millennium," *Communication Monographs*, 76(4), 408–20.

Heatherton, T F and J Polivy (1991), "Development and Validation of a Scale for Measuring State Self-Esteem." *Journal of Personality and Social Psychology*, 60(6), 895–910.

Javornik, Ana (2016), "'It's an Illusion, but It Looks Real!' Consumer Affective, Cognitive and Behavioral Responses to Augmented Reality Applications," *Journal of Marketing Management*, 32(9–10), 987–1011.

Javornik, Ana, Yvonne Rogers, Delia Gander, and Ana Moutinho (2017), "MagicFace : Stepping into Character through an Augmented Reality Mirror," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems '17*, Denver, Colorado: ACM.

Jin, Seung A Annie (2012), "The Virtual Malleable Self and the Virtual Identity Discrepancy Model: Investigative Frameworks for Virtual Possible Selves and Others in Avatar-Based Identity Construction and Social Interaction," *Computers in Human Behavior*, 28(6), 2160–68.

Jussila, Iiro, Anssi Tarkiainen, Marko Sarstedt, and Joseph F Hair (2015), "Individual Psychological Ownership: Concepts, Evidence, and Implications for Research in Marketing," *Journal of Marketing Theory and Practice*, 23(2), 121–39.

Kim, Jiyeon and Sandra Forsythe (2008), "Adoption of Virtual Try-on Technology for Online Apparel Shopping," *Journal of Interactive Marketing*, 22(2), 45–59.

Labroo, Aparna A, Ravi Dhar, and Norbert Schwarz (2008), "Of Frog Wines and Frowning Watches: Semantic Priming, Perceptual Fluency, and Brand Evaluation," *Journal of Consumer Research*, 34(6), 819–31.

Lee, Angela Y. and Aparna A. Labroo (2004), "The Effect of Conceptual and Perceptual Fluency on Brand Evaluation," *Journal of Marketing Research*, 41, 151–65.

Li, Ting and Zornitsa Meshkova (2013), "Examining the Impact of Rich Media on Consumer Willingness to Pay in Online Stores," *Electronic Commerce Research and Applications*, 12(6), 449–61.

Moreau, C. Page, Leff Bonney, and Kelly B Herd (2011), "It's the Thought (and the Effort) That Counts: How Customizing for Others Differs from Customizing for Oneself," *Journal of Marketing*, 75(5), 120–33.

Peck, Joann and Suzanne B. Shu (2009), "The Effect of Mere Touch on Perceived Ownership," *Journal of Consumer Research*, 36(3), 434–47.

Randall, Taylor, Christian Terwiesch, and Karl T. Ulrich (2007), "User Design of Customized Products," *Marketing Science*, 26(2), 268–80.

Schau, H. J., & Gilly, M. C (2003), "We Are What We Post? Self- Presentation in Personal Web Space.," *Journal of Consumer Research*, 30(3), 385–404.

Scholz, Joachim and Andrew N. Smith (2016), "Augmented Reality: Designing Immersive Experiences That Maximize Consumer Engagement," *Business Horizons*, 59(2), 149–61.

Sheth, Jagdish N. and Michael R. Solomon (2014), "Extending the Extended Self in a Digital World," *The Journal of Marketing Theory and Practice*, 22(2), 123–32.

Siddiqui, Shakeel and D Turley (2006), "Extending the Self in a Virtual World," *Advances in Consumer Research*, 33, 647–48.

Sirgy, Joseph (1986), "Self-Concept in Consumer Behavior : A Critical Review," *Journal of Consumer Research*, 9(3), 287.

Zhao, Xinshu, John G. Lynch Jr., and Qimei Chen (2010), "Reconsidering Baron and Kenny: Myths and Truths about Mediation Analysis," *Journal of Consumer Research*, 37(2), 197–206.